Jan. 22, 1952 R. W. BAILEY 2,583,315

ANNULAR FORGING AND CASTING

Filed March 21, 1947 2 SHEETS—SHEET 1

Fig. 1.

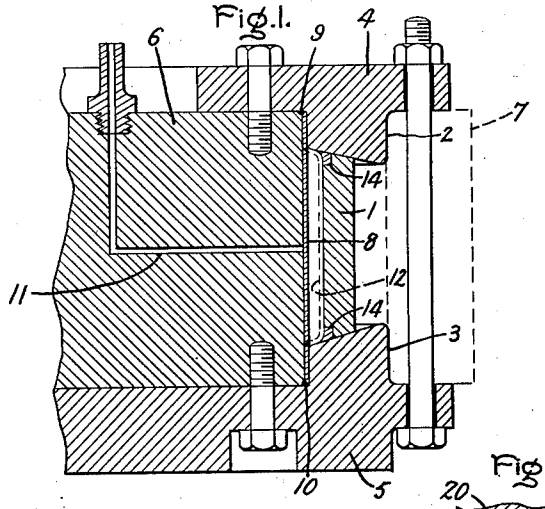


Fig. 2.

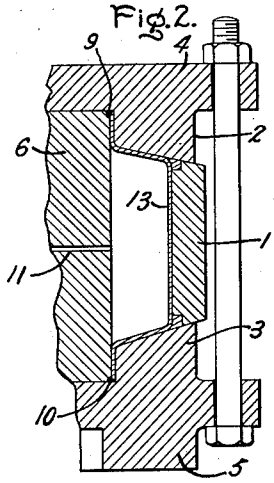


Fig. 3.

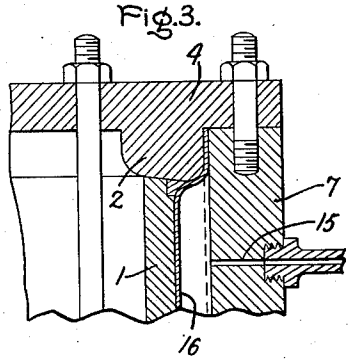


Fig. 4.

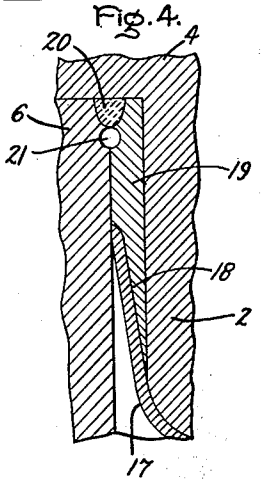


Fig. 5.

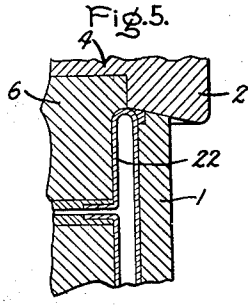


Fig. 6.

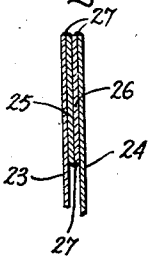


Fig. 7.

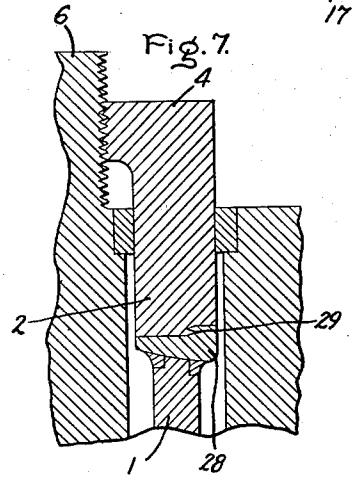
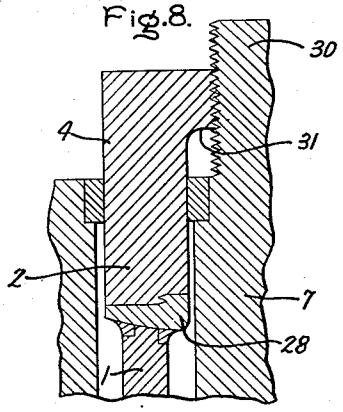


Fig. 8.



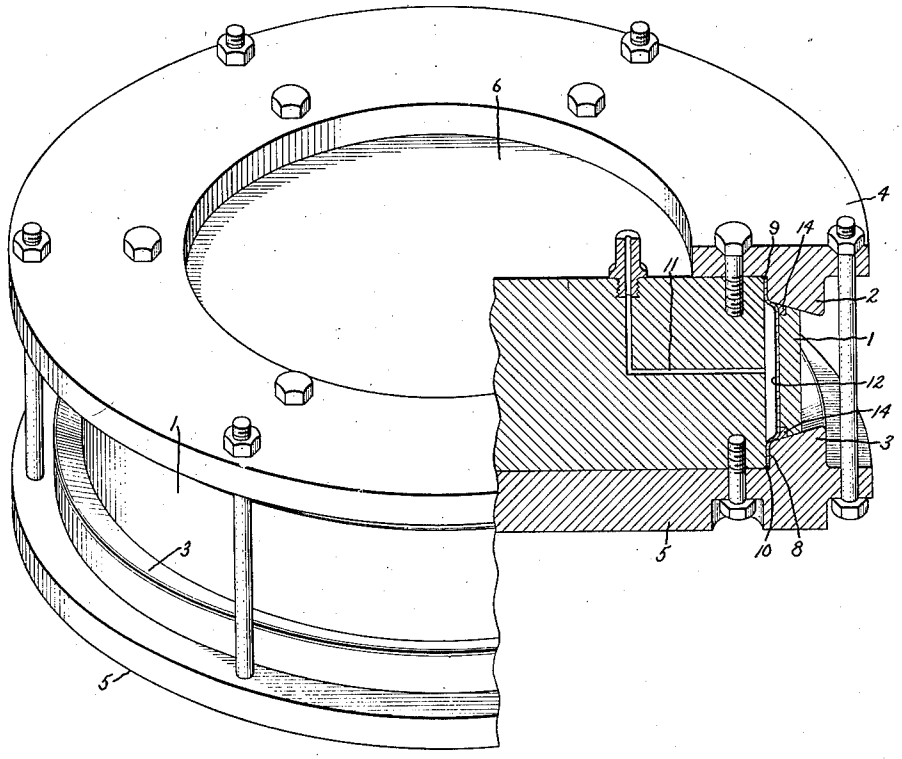
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ANNULAR FORGING AND CASTING

Filed March 21, 1947 2 SHEETS—SHEET 2

Fig. 9.



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UNITED STATES PATENT OFFICE

2,583,315

ANNULAR FORGING AND CASTING

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Application March 21, 1947, Serial No. 736,382
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Section 1, Public Law 690, August 8, 1946
Patent expires November 2, 1964

5 Claims. (Cl. 78—42)

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This invention relates to the treatment of annular metal forgings or castings to strain-harden or improve the tensile properties by plastic deformation, involving either circumferential extension or circumferential compression, or both in succession, the maximum deformation being either effected in one stage or in a series of stages.

According to the invention the circumferential deformation is effected, while the annular member is carried in an apparatus, by hydraulic pressure applied to the inner or outer cylindrical surface of the member through the intermediary of a relatively thin-walled fluid-containing member (hereinafter referred to as the shell) which is of material which, at least under favorable conditions, can itself undergo a considerable degree of deformation without failure. The material may be, for example, an annulus of annealed copper, soft iron or steel, or indiarubber or other elastic non-metallic material. The apparatus comprises a rigid inner cylinder or an outer cylinder, or both, through either or each of which cylinders the hydraulic fluid can be admitted through one or both ducts so as to deform the annular shell which is, of course, connected at its edges to either or each of said cylinders in a high-pressure, fluid-tight manner, or is constructed as a hollow annulus similar to the pneumatic inner tube of the tire of a vehicle wheel.

The apparatus further comprises "cover" members; namely, assuming that the cylinders and the annuli all have a vertical axis, there will be upper and lower cover plates which are adapted to be secured, such as by means of bolts or set-screws, to either or each rigid cylinder or both and each is provided with a flange, and the annular forging or casting to be deformed is retained between these flanges, the forging or casting being of shorter axial length than the rigid cylinders.

According to a subsidiary feature of the invention, the flanges just above mentioned, or other parts against which the upper and lower edges of the shell bear, are rounded to avoid excessive localized strain on the shell. In other words, when the shell is deformed, no part of it bears against a square or angular edge. To the same end, the annular forging or casting may be provided with a fillet separately applied and afterwards removed if desired.

The faces of the aforesaid cover flanges are conical so that as the annular forging or casting is circumferentially extended or compressed, the concomitant reduction or increase respectively in its axial length is accommodated.

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Where the shell is of non-metallic material, for example rubber, its upper and lower ends may be cemented to metal tubes which surround the upper and lower ends of, for instance, the rigid inner cylinder and are welded thereto. The tube is preferably chamfered to a fine edge such that the latter runs tangentially into the curved edge of the flange of a cover member.

Where the "inner tube" form of shell is used, it may be made of indiarubber or metal. In the latter case, the upper and lower edges may be given a bellows formation by welding.

Where the shell member is of metal, it may be welded at its extreme upper and lower edges to the edges of the inner or outer rigid cylinder, but with this arrangement it will be appreciated that the shell will have to be removed and renewed for each operation so that the inner tube form may be preferred when large quantities of the annular forgings or castings are required to be treated.

A lubricant may be employed to facilitate the necessary relative sliding between the shell on the one hand and the end cover flanges and forging or casting on the other hand. Alternatively, or in addition, the pressure for any one forging or casting may be applied in stages to allow the shell to relieve itself of high local strain and adjust its position favorably for the next stage.

It will be appreciated that the cover members may further be rigidly held together by means of additional bolts and nuts.

It will also be appreciated that when the apparatus has an internal rigid cylinder, as well as an extra one for subjecting the annular forging or casting successively to circumferential extension and compression, it will be necessary to adjust the bolts and set-screws to allow for the difference in axial elastic strain or the alteration in axial length in the forging or casting. However, the screws and bolts may be made sufficiently elastic to take care of this change, or spring washers may be provided for the screws and bolts.

While there has hereinbefore been described a continuous annular shell, it will be understood that the mechanical equivalent may be obtained by employing a plurality of segments or a plurality of rings or collars or even a helical tubular coil.

In some cases it may be considered desirable to make provision for the treatment of forgings

of different axial lengths while using the same basic apparatus. Such provision entails the adjustment of the gap between the aforesaid cover members and also the change or adjustment of the conical faces of these members, the reason for the latter being that the axial contraction or extension of the forged or cast annulus for a given increase or decrease in diameter will be proportional to the axial length of the annulus.

One way of making the provision referred to in the preceding paragraph, according to a subsidiary feature of the invention, consists in using sets of cover members having axial flanges of predetermined different lengths.

Alternatively, one pair of cover members may be usefully adapted by securing to them selected pairs of sets of extension pieces or shoes according to the axial length of the annulus to be clamped between the flanges of the cover members.

In a further and preferred arrangement, the "cover" members may be modified and arranged in relation to the main support member or members so as to be adjustable in the axial direction with respect thereto. Thus, the flange may have screw-threaded engagement with the main supporting member or members.

To enable the invention to be fully understood, it will now be described by way of example with reference to the accompanying drawings, all of which are fragmentary sectional elevations of apparatus in accordance with the invention.

Fig. 1 shows one arrangement with the annulus in its initial position.

Fig. 2 is in part similar to Fig. 1 showing the annulus in its final circumferentially extended position.

Figs. 3 to 8 show detail modifications of the apparatus shown in the main in Fig. 1.

Fig. 9 is a perspective view of the device partially illustrated in Fig. 1 with the annulus in its initial position and the shell expanded into engagement with the annulus.

Referring first to Fig. 1 and also Fig. 9, at 1 is shown the annulus to be treated. It is clamped at its ends between the axial flange portions 2 and 3 of the upper and lower cover members 4 and 5 respectively which mounts the annulus 1 concentrically and in spaced relation with the cylindrical member 6. These members 4 and 5 are bolted or otherwise securely fixed to the inner rigid cylinder 6 while there may be an outer cylinder 7 as indicated in chain lines in Fig. 1.

At 8 is shown the deformable shell which is welded at its upper and lower ends to the upper and lower edges respectively of the cylinder 6, as indicated at 9 and 10. The cylinder 6 is provided with ducting indicated at 11 communicating with the cylindrical surface of member 6 whereby hydraulic pressure can be applied to the interior of the shell 8 which, on the application of relatively low pressure, is caused to swell out so as to engage the inner surface of the annulus 1, as indicated at 12 in Figs. 1 and 9.

It will be seen that the end faces of the flanges 2 and 3 and of the annulus 1 are conical for the reason hereinbefore explained.

In Fig. 2 the annulus is shown in its fully extended condition and position having been forced by the further hydraulically deformed shell indicated at 13.

In Figs. 1 and 2, at 14 are shown the lipped fillets separately applied to the annulus 1, for the purpose hereinbefore stated.

Referring next to Fig. 3, the arrangement shown

in this figure is one in which the annulus 1 is adapted to be subjected to circumferential compression with or without its having been, or going to be, subjected to circumferential extension. For this purpose the outer supporting cylinder 7 (as indicated in chain lines in Fig. 1) is employed having the ducting 15 for the hydraulic fluid and having the shell 16 secured to it as will be readily understood.

Referring to Fig. 4, this differs from the arrangement shown in Fig. 1 in that the deformable shell 17 is rubber or other non-metallic material. Its upper end and lower end (not shown) are cemented along the chamfered edge 18 of the metal tube 19 which is welded at 20 to the top edge of the cylinder 6. The chamfering of the tube 19 at its lower end is such that it runs tangentially into the curved inner edge of the flange 2. At 21 is shown the groove beneath the weld 20 to minimize the stress concentration.

In Fig. 5 there is shown the "inner tube" type of shell as indicated at 22, this tube being of deformable non-metallic material, for example rubber.

In Fig. 6 is shown a portion of an "inner tube" type of shell constructed of metal of bellows formation comprising, for example, the inner and outer plates 23 and 24, and between them the bellows plates 25 and 26. All the plates are welded as indicated in cross section by the spots 27.

Referring to Fig. 7, it will be seen that the arrangement shown comprises the modification which consists in the "cover" member 4 having screw-threaded engagement with the exterior of the member 6 so as to be adjustable axially in respect to the latter for the purpose hereinbefore set forth.

Fig. 7 shows also an alternative or additional provision, namely, of the annular shoe 28 which may be attached to the lower face of the flange 2 such as by the mutual screw-thread indicated at 29.

In Fig. 8 there is also shown an optional addition, namely, an upper extension 30 of the supporting cylinder 7, shown in Figs. 1 and 3, which may have sliding or screw-threaded engagement with an extension 31 of the member 4.

While I have shown particular embodiments of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Apparatus for improving the tensile properties of an annular metallic member by plastic deformation which comprises a cylindrical member having a passage for conducting fluid to the cylindrical surface of said cylindrical member and positioning means including a pair of oppositely disposed conical flanges for mounting said annular metallic member concentrically and in spaced relation with said cylindrical member thereby defining an annular pressure chamber for receiving fluid under pressure from said passage.

2. Apparatus for improving the tensile properties of an annular metallic member by plastic deformation which comprises a pair of concentrically disposed cylindrical members having fluid conducting passages for conducting fluid to the cylindrical surface of said cylindrical

members and positioning means including a pair of oppositely disposed conical flanges for mounting said annular metallic member concentrically and in spaced relation between said cylindrical members thereby defining annular pressure chambers adjacent the periphery of said cylindrical members and in communication with said passages.

3. Apparatus for improving the tensile properties of an annular metallic member by plastic deformation which comprises a cylindrical member having a passage for conducting fluid to the cylindrical surface of said cylindrical member, positioning means including a pair of oppositely disposed conical flanges for mounting said annular metallic member concentrically and in spaced relation with said cylindrical member, a thin-walled annulus fixedly attached to the peripheral edges of said cylindrical member thereby defining an annular deformable pressure chamber in communication with said pressure.

4. Apparatus for improving the tensile properties of an annular metallic member by plastic deformation which comprises a cylindrical member having a passage for conducting fluid to the cylindrical surface of said cylindrical member, oppositely disposed conical flanges for mounting said annular metallic member concentrically and in spaced relation with said cylindrical member, an annular deformable tube communicating

with said passage, said tube defining a pressure chamber between said cylindrical member and said annular metallic member.

5. Apparatus for improving the tensile properties of an annular metallic member by plastic deformation which comprises a cylindrical member having a passage for conducting fluid to the cylindrical surface of said cylindrical member, positioning means including a pair of oppositely disposed conical flanges for mounting said metallic member concentrically and in spaced relation with said cylindrical member thereby defining an annular pressure chamber for receiving fluid under pressure from said passage, said positioning means being adjustable to accommodate annular metallic members of different axial length.

RICHARD W. BAILEY.

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